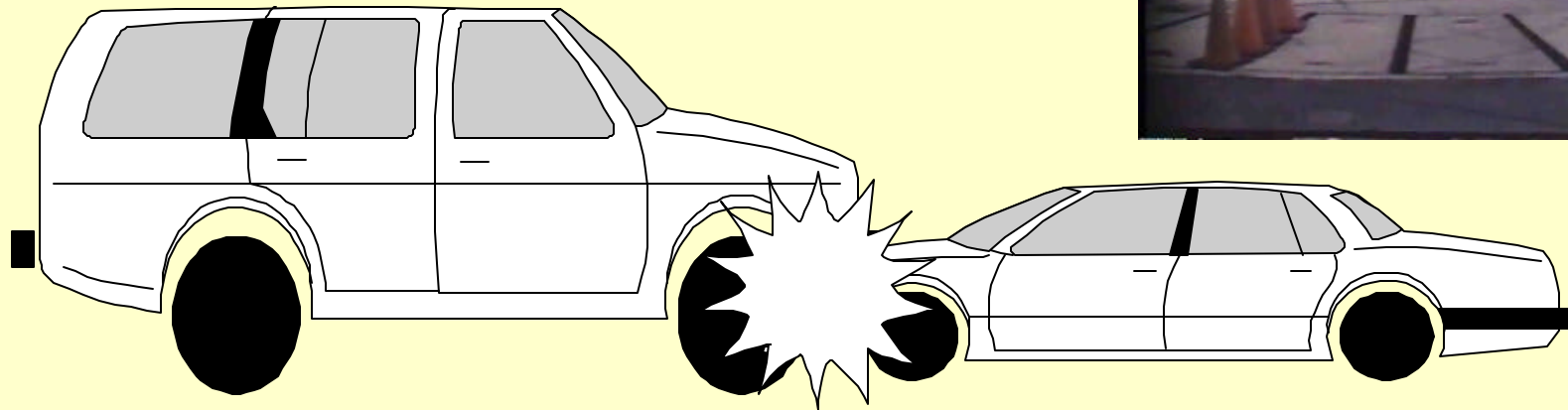
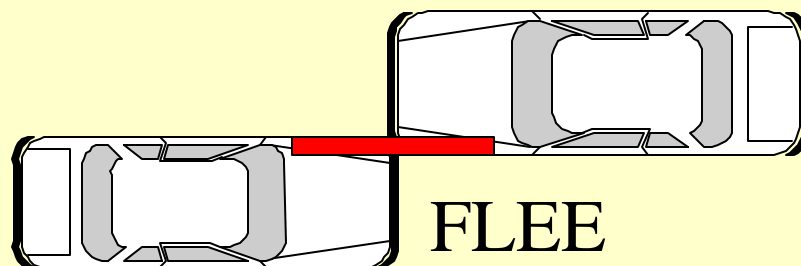


# Offset Frontal Impacts into SUVs



& Corner to Corner called FLEEs.

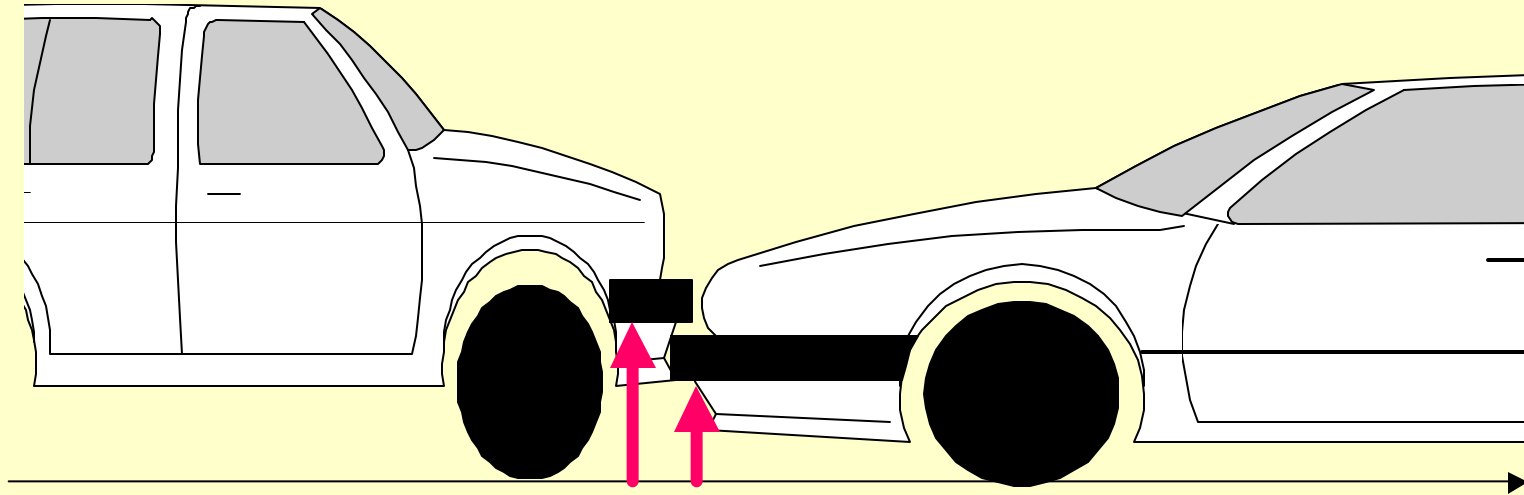


**SEATTLE CIREN**

**Rob Kaufman, BS**

**Charles Mock, MD, Ph.D.**

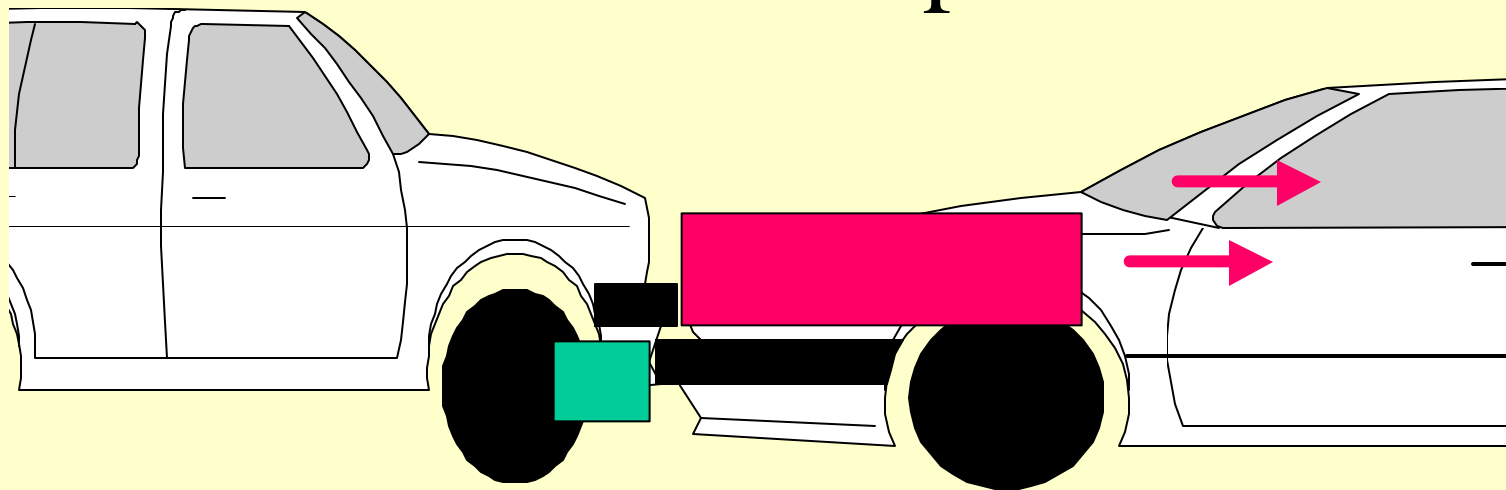
# SUV vs. Sedan





Obvious mismatch in bumper heights

# SUV vs. Sedan

Override impact creates significant intrusion of instrument panel/hood



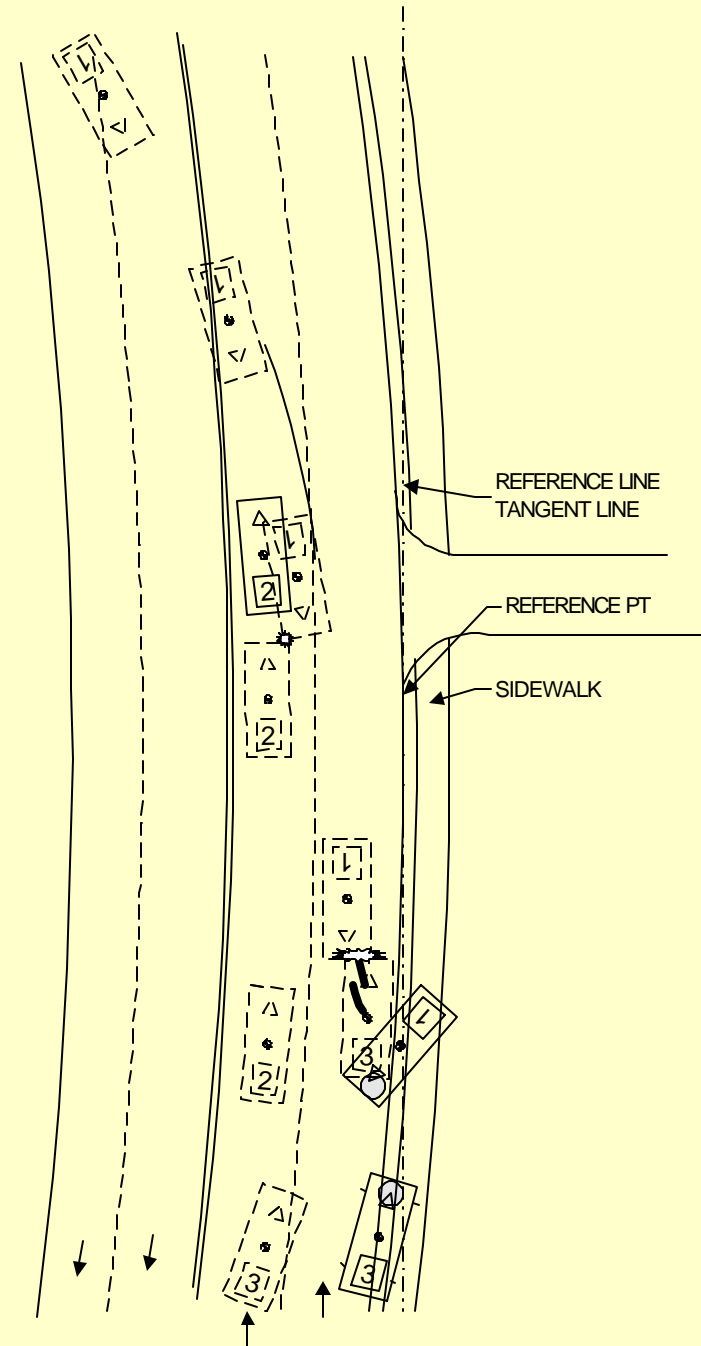
 SUV bumper into grill of sedan

 Sedan bumper into front tire/axle

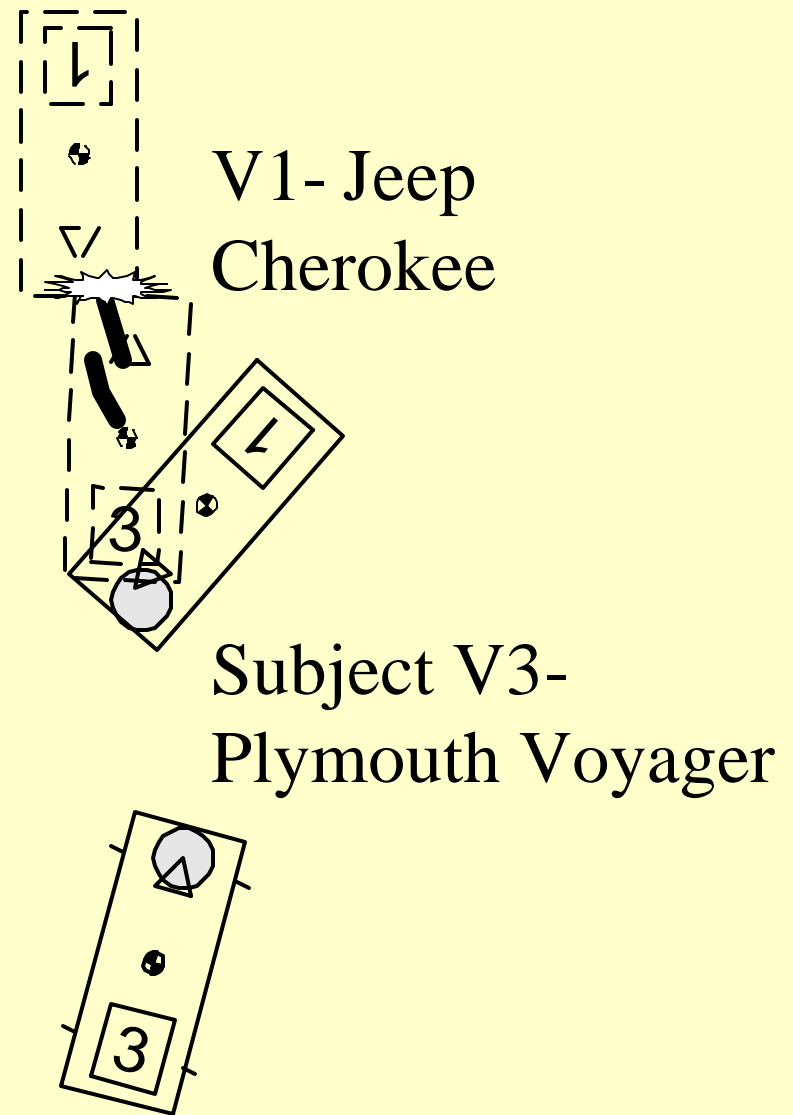
# SUV vs. Minivan



Posted Speed limit = 30 mph



# SUV vs. Minivan





# SUV vs. Minivan



Jeep Cherokee

Delta V = 26 mph



# SUV vs. Minivan



Plymouth Voyager

Delta V = 27 mph



Offset = 63%

# Demographics/Intrusions

**Driver - 30's yr**

**Restraints:**

**\_\_\_\_\_Lap/shoulder belt**

**Airbag**

**Deployment**

**Driver Area Intrusions**

**Toe pan = 45 cm**

**Instr.Panel = 42 cm**

**A pillar = 52 cm**

**Windshield = 24 cm**

**Kick panel = 18 cm**

**Steering col. = 15 cm**

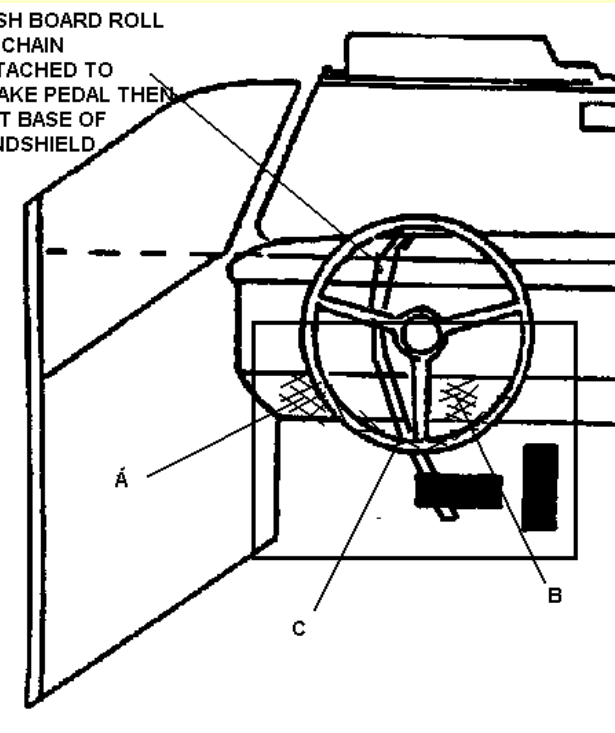




# Driver Entrapment



DASH BOARD ROLL  
UP CHAIN  
ATTACHED TO  
BRAKE PEDAL THEN  
OUT BASE OF  
WINDSHIELD



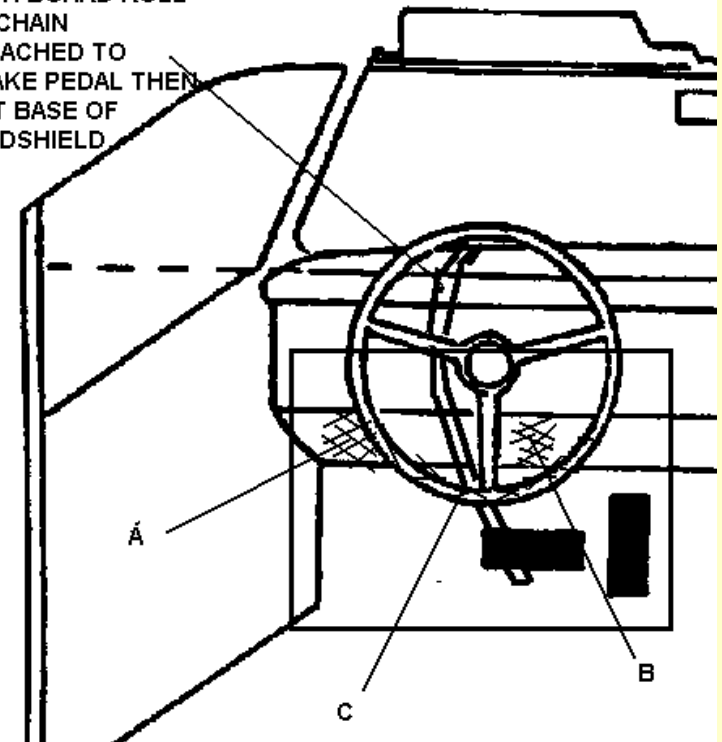
Dashboard Rollup

Dashboard on top of legs with both mid-shaft femurs fx'd

# Driver Contacts



DASH BOARD ROLL  
UP CHAIN  
ATTACHED TO  
BRAKE PEDAL THEN  
OUT BASE OF  
WINDSHIELD



Both Knees contacted into bolster area

Steering Rim Deformity

## Course of Treatment

30's yrs. restrained driver in frontal offset MVC.  
AB deployment.

Prolonged extrication

Stable in route.

Initial evaluation in ER: Stable VSs. Bilat LE Fxs.

# X-rays



Right Midshaft  
Femur fracture



L intertrochanteric  
hip fracture

Left midshaft  
femur fracture

## X-rays

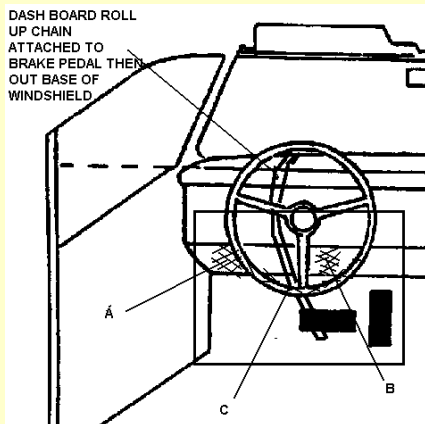


Right tibial plateau fx, comm.



Left tibial plateau fx, comm.





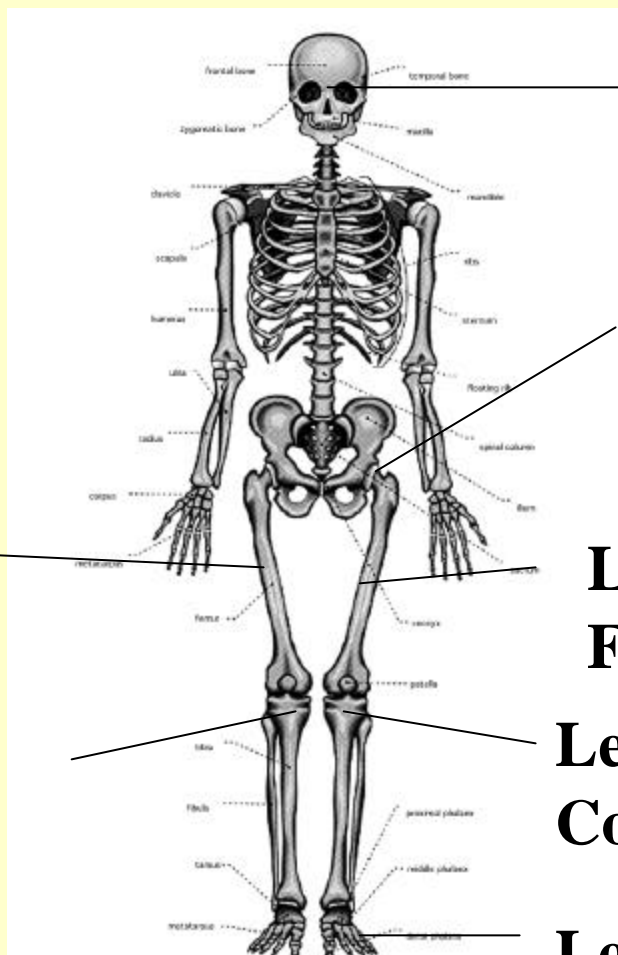
# Injury Summary

## Driver

ISS = 10

**Right Midshaft  
Femur Fx**

**Right Tibial  
Plateau  
Comminuted Fx**



**Minor chin  
and cheek  
abrasions**

**Left intertrochanteric  
hip fx**

**Left Midshaft Femur  
Fx**

**Left Tibial Plateau  
Comminuted Fx**

**Left third toe fx**

# Injury Summary

AIS

## Face

Multiple abrasions and contusions 1

## Lower Extremity

L: Midshaft femur fx 3

Intertrochanteric hip fx 3

R: Midshaft femur fx 3

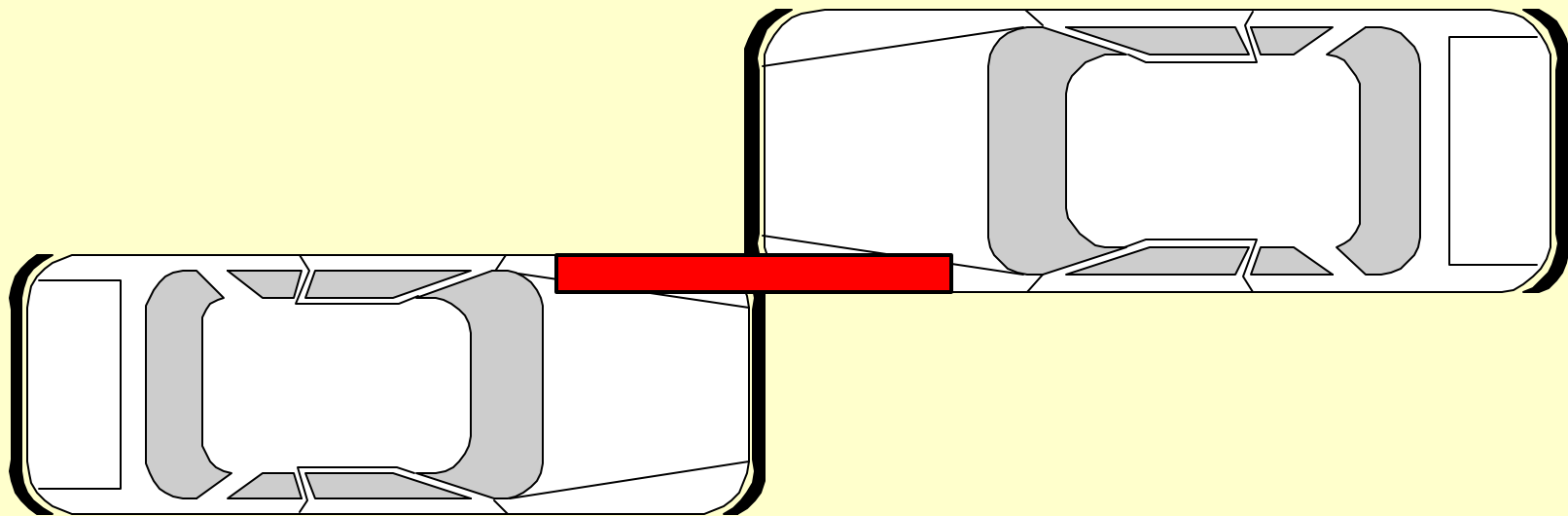
Bilat: Tibial plateau fx, comminuted 3

L third toe fx 1

MAIS 3

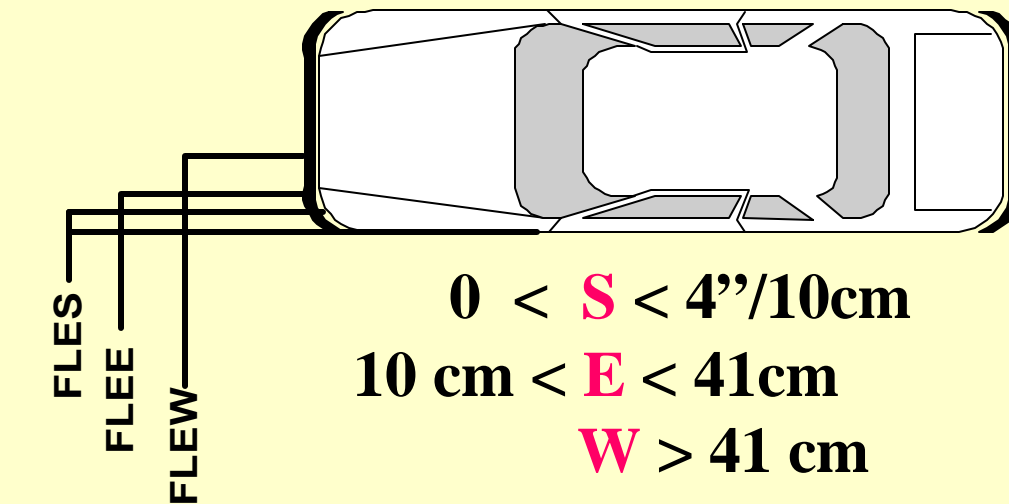
ISS 10

# FLEE Head-on or Corner to Corner Impacts



# FL EE Review

## Collision Deformation Classification Code



**12 - O'clock**

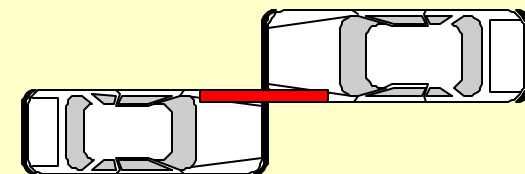
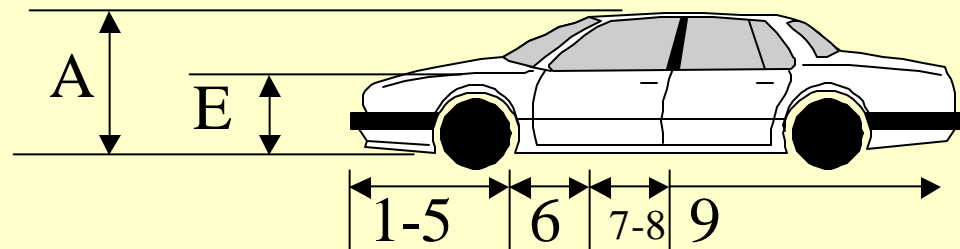
**F - Front**

**L - Left**

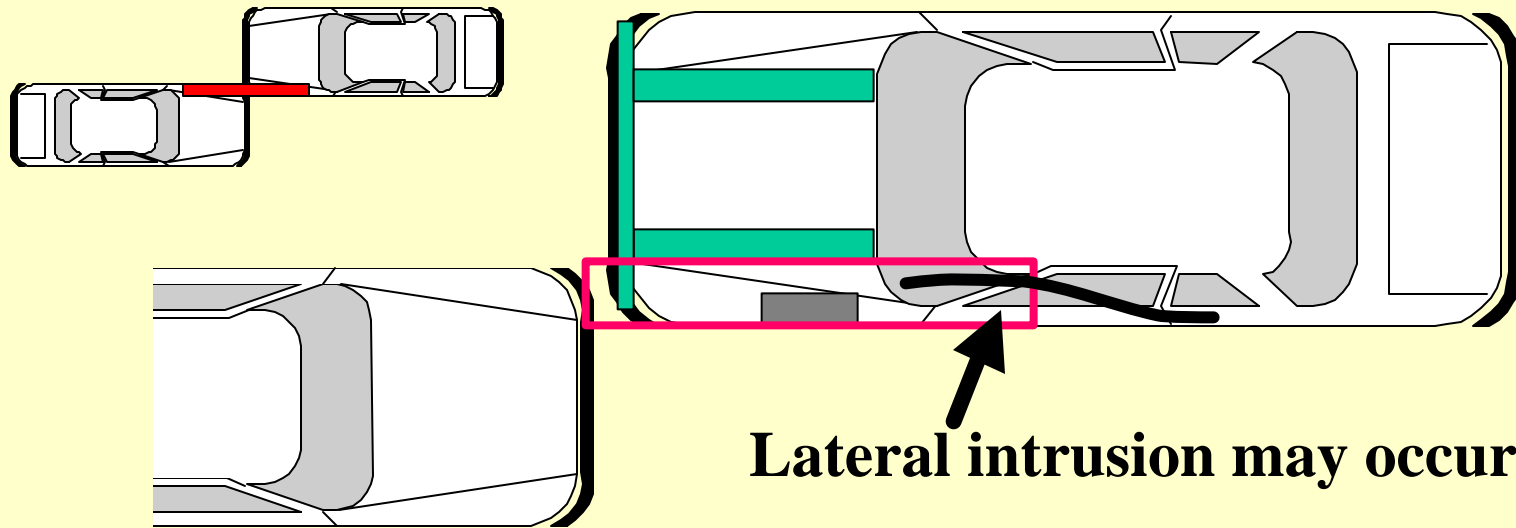
**E - Vertical/Height**

**E - Corner(dam.width)**

**# - Extent zone**



# FLEE Offset Impacts



- **Frame rail gets partial hit, or even missed**
- **Bumper frame doesn't extend to corner with any support**
- **With hollow fender well the impact will make contact into the wheel/axle and at the base of A pillar**
- **Longitudinal intrusion of toe pan, instrument panel, steering column, with even lateral intrusion of door and floor panels.**



# FL EE Case Review

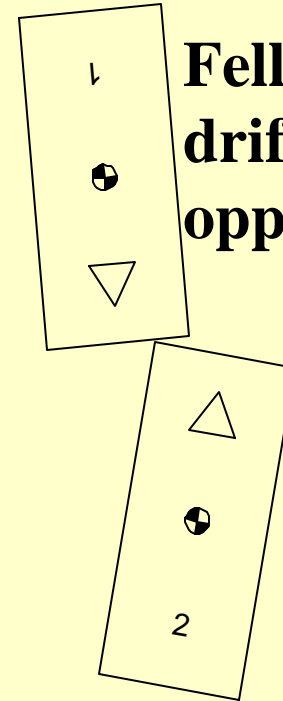
**Olds Cutlass**

**Fell asleep  
drifted into  
opposite lane**



Typical wet rainy afternoon

Speed limit 45 mph



**Subject Vehicle**

**Ford Aerostar**

# FLEE Case Review

## Striking Vehicle



Olds. Cutlass

Delta V = 34 mph

## Ford Aerostar Van

Delta V = 29 mph



Corner Impact misses frame rail

# FLEE Case Review

**Ford Aerostar Van**

**Delta V = 29 mph, 32% Offset**



12FLEE9

Corner Impact misses frame rail

# Demographics/ Intrusion



**Driver -**  
**30's yrs.**

**Restraint -**  
**No belts,**  
**Airbag Clothing -**  
**Blue coveralls**



## **Driver Area Intrusion**

**Kick panel - 42 cm - Lat.**

**Instr. Panel -35 cm - Long.**

**B pillar - 32 cm - Lat.**

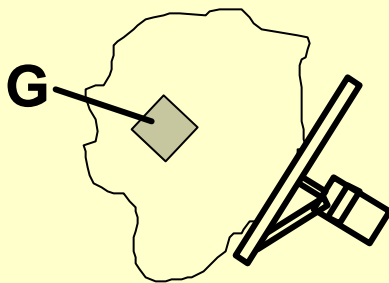
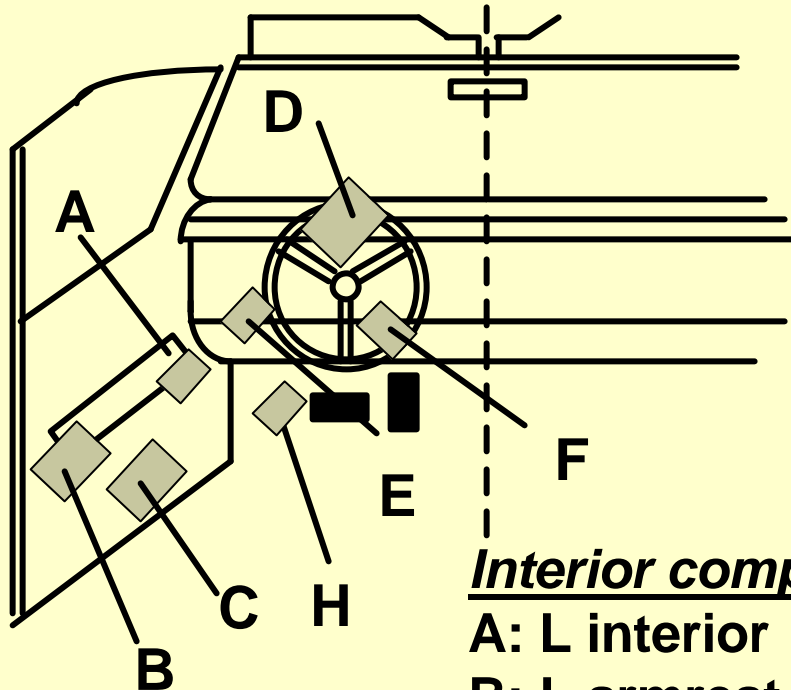
**Toe pan - 25 cm -Long**

**Door Panel - 25 cm - Lat.**

**A pillar - 22 cm -Long.**



# Driver Contacts



<i><b>Interior component</b></i>	<i><b>Body Region</b></i>	<i><b>Evidence</b></i>
A: L interior	L leg	Fabric transfer
B: L armrest	L hip	Fabric transfer
C: L interior	L hip	Smashed
D: Steering wheel	Chest	Deformed
E: L inst panel	L knee	Dented/ fabric
F: L inst panel	R knee	Dented/ fabric
G: Air bag	Arm	Fabric transfer
H: Kickpanel/Toe pan	L lower leg	Blood



# Injury Summary



**Left unla fx and  
radial head fx/disloc**

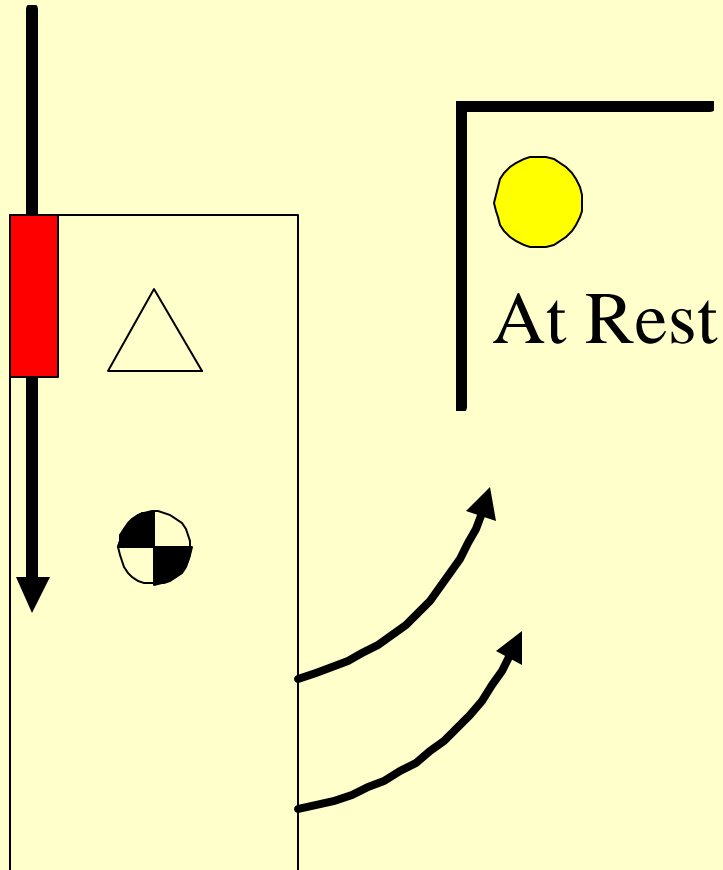
**Left acetabular fx**

**Left Fibula shaft fx,  
comm.**

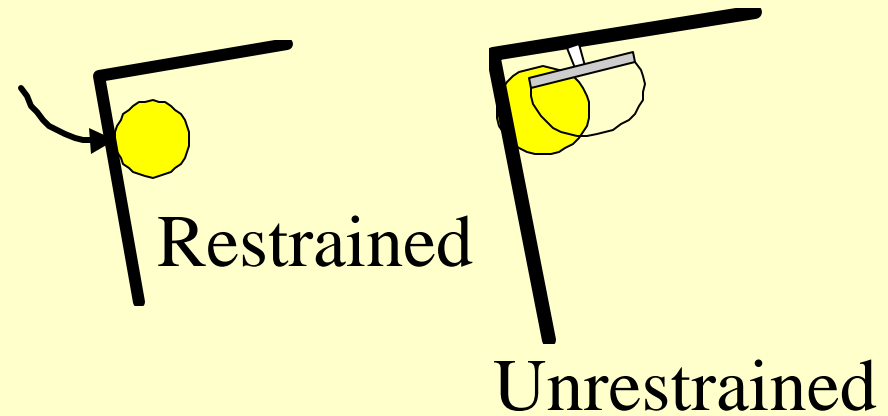
**Left Tibial Pilon Fx  
displaced joint**



# FLEE and Rotation

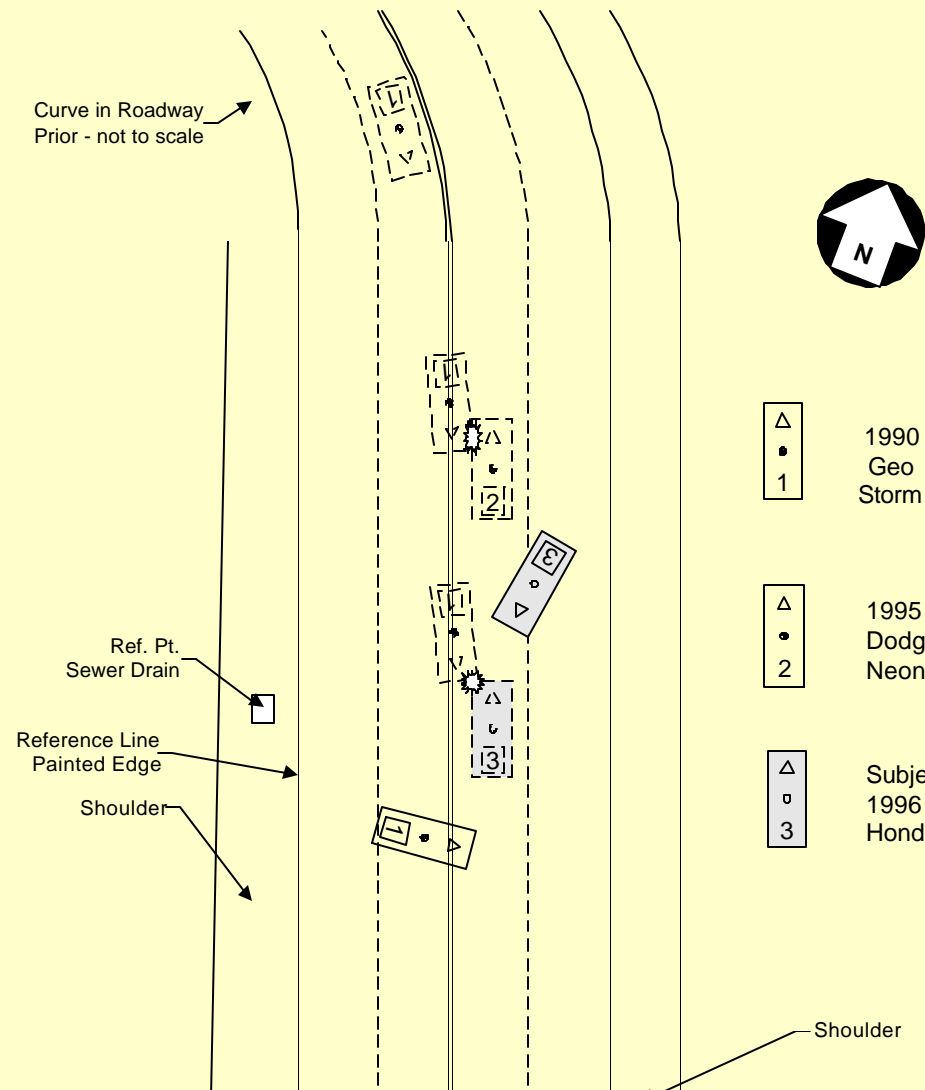


Corner impact can produce rotation of vehicle



- Belted - Door panel rotates into driver
- Unbelted - vehicle rotates and driver impacts left of the steering column

# FLEE/Rotation Case



Posted Speed = 40 mph

Wet Roadway, Clear

CV/V3 - Honda Civic

Struck by Geo Storm

# FLEE Rotation Case Review



Event  
2

PDOF  
355

CDC  
12FLEE6

Delta V  
27 mph  
(Oldmiss)



# Demographics

## Intrusions

### Subject Driver

40's male.

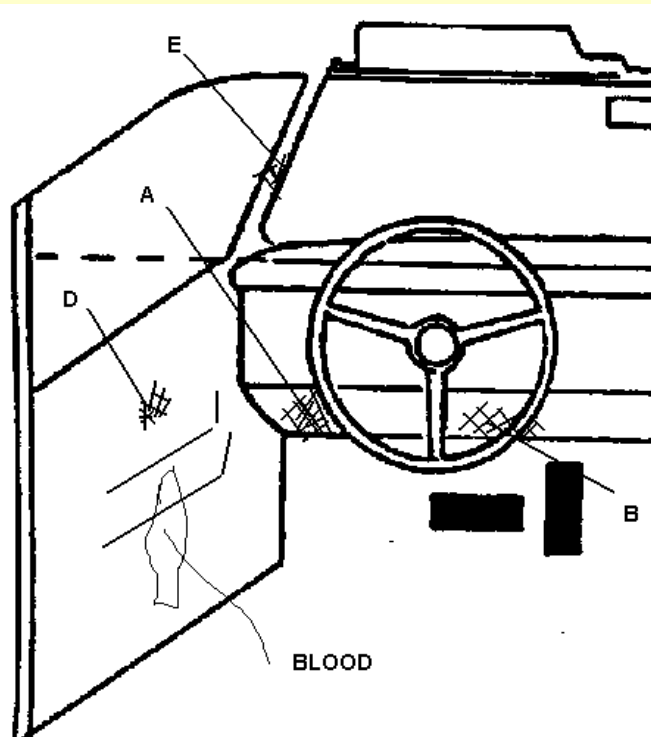


Row	Position	Area	Intruded Component	Comparator	Intruded	Intruder	Magnitude	Crush Direction
Front Seat	Left	Interior	Instrument panel left	87	64	23	>= 15 to < 30 cms	Longitudinal
Front Seat	Left	Interior	Toe pan	134	110	24	>= 15 to < 30 cms	Longitudinal
Front Seat	Left	Interior	Side panel - forward of	111	92	19	>= 15 to < 30 cms	Longitudinal
Front Seat	Left	Interior	A (A1/A2)-pillar	98	80	18	>= 15 to < 30 cms	Longitudinal
Front Seat	Left	Interior	Steering Assembly	67	55	12	>= 8 to < 15 cms	Longitudinal
Front Seat	Left	Interior	Windshield	102	90	12	>= 8 to < 15 cms	Longitudinal
Front Seat	Middle	Interior	Instrument panel center	87	82	5	>= 3 to < 8 cms	Longitudinal
Front Seat	Right	Interior	Instrument panel right	87	85	2	<= 2 cms	Longitudinal

Mainly Longitudinal

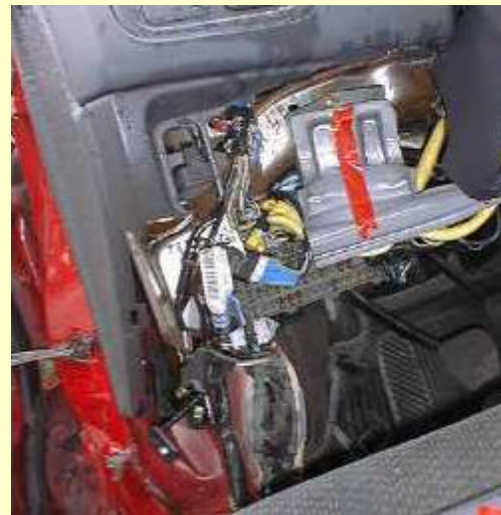
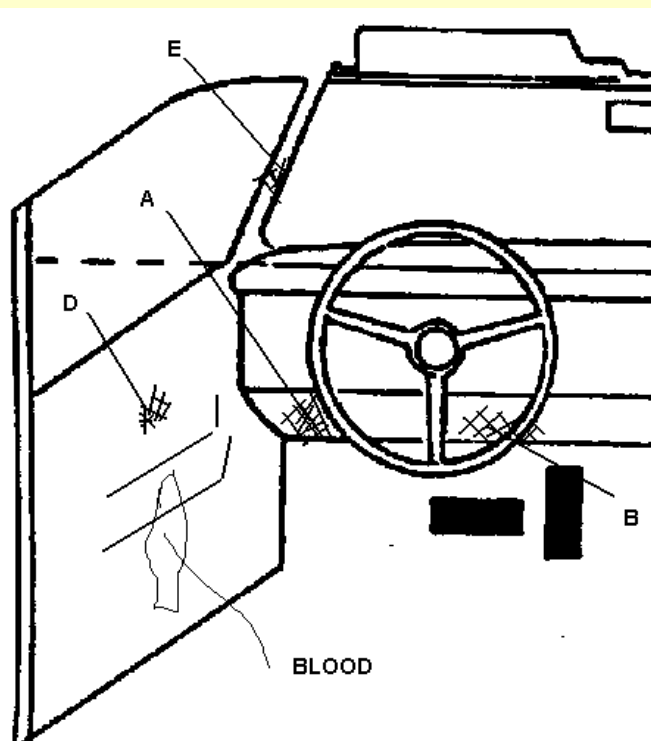


# Driver Contacts



Contact	Area	Component	Occ #	Body Region	Evidence	Confidence
A	Front	Knee bolster	1	Knee - Left	Deformed	CERTAIN
B	Front	Knee bolster	1	Knee - Right	Scuffed	CERTAIN
C	Front	Steering column,transmission sele	1	Knee - Right	Scuffed	PROBABLE
D	Left Side	Left side interior surface, excl. h	1	Elbow - Left	Deformed	PROBABLE
E	Left Side	Left A (A 1/A2)-pillar	1	Upper Arm - Left	Scratched	POSSIBLE

# Driver Contacts



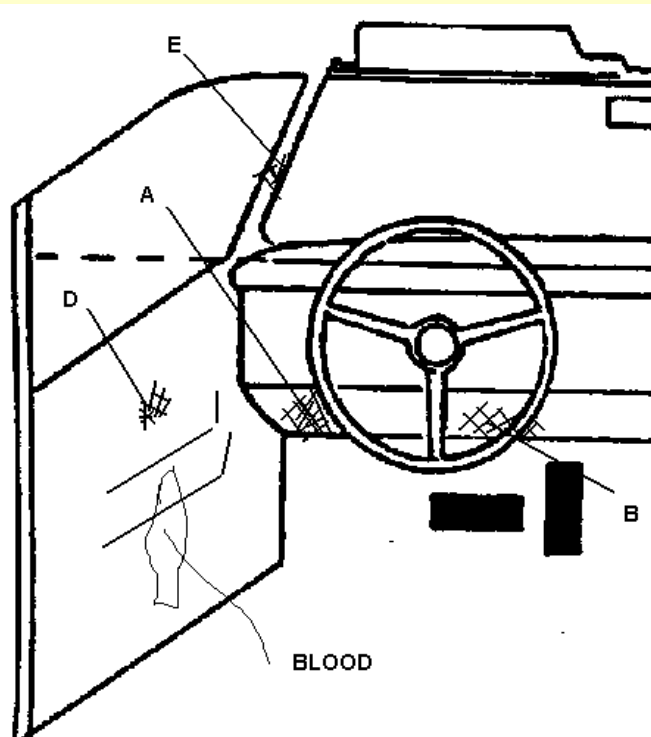
Left knee



Right Knee

Contact	Area	Component	Occ #	Body Region	Evidence	Confidence
A	Front	Knee bolster	1	Knee - Left	Deformed	CERTAIN
B	Front	Knee bolster	1	Knee - Right	Scuffed	CERTAIN
C	Front	Steering column,transmission sele	1	Knee - Right	Scuffed	PROBABLE
D	Left Side	Left side interior surface, excl. h	1	Elbow - Left	Deformed	PROBABLE
E	Left Side	Left A (A 1/A2)-pillar	1	Upper Arm - Left	Scratched	POSSIBLE

# Driver Contacts



Contact	Area	Component	Occ #	Body Region	Evidence	Confidence
A	Front	Knee bolster	1	Knee - Left	Deformed	CERTAIN
B	Front	Knee bolster	1	Knee - Right	Scuffed	CERTAIN
C	Front	Steering column,transmission sele	1	Knee - Right	Scuffed	PROBABLE
D	Left Side	Left side interior surface, excl. h	1	Elbow - Left	Deformed	PROBABLE
E	Left Side	Left A (A 1/A2)-pillar	1	Upper Arm - Left	Scratched	POSSIBLE



# Driver Contacts



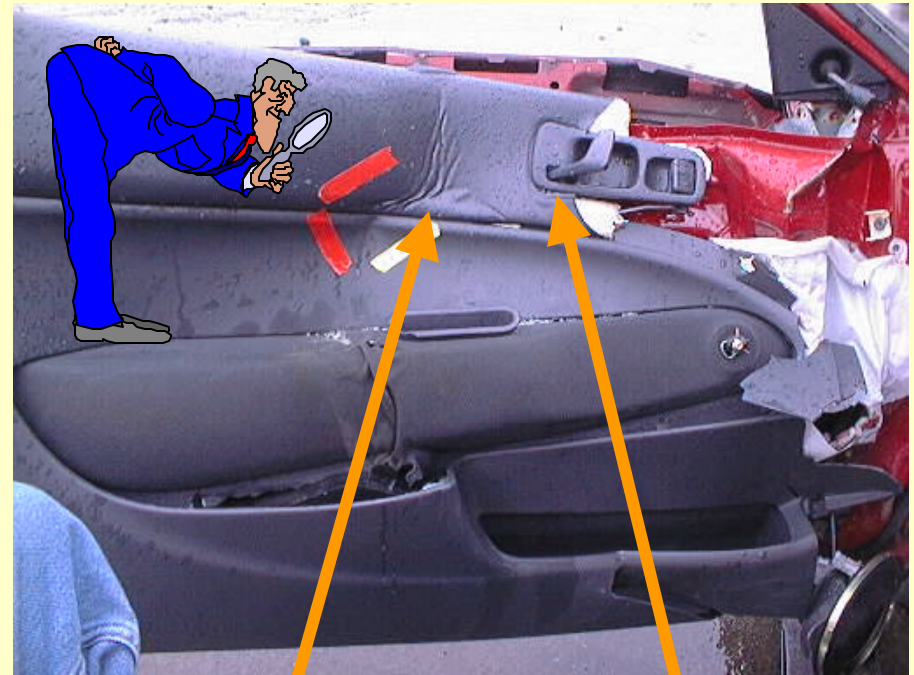
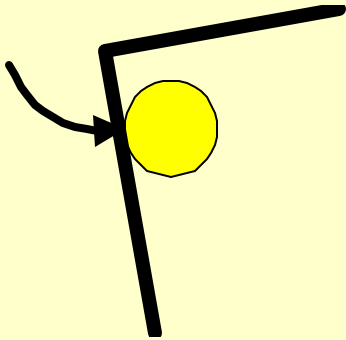
Top view - Door panel

No lateral intrusion,  
outward bowing from  
impact and possible contact



Deformation occurring  
in door panel

# Driver Contacts



Soft/pocketing

Stiff  
Hardware

## Course of Treatment

40's year old man. Restrained driver in frontal MVC. AB deployment.

Initial evaluation:

Stable

Complained of R foot and L elbow pain

# X-rays



L open comminuted ulna fx

L radial head disloc with radial nerve palsy

(NB: Monteggia fractures prone to radial nerve palsy)



## INJURIES:

**AIS**

### Face

Abrasions: R temple, midface; Central chin 1

### Chest

Ant chest wall abrasion 1

### Upper Ext

L open comminuted ulna fx 3

L radial head disloc with radial nerve palsy 3

(NB: Monteggia fractures prone to radial nerve palsy)

### Lower Ext

L lateral malleolus fx (Weber A) 2

Peroneal sheath avulsion

R proximal fibular fx (spiral) 2

R sesamoid fx / R 1<sup>st</sup> MT fx disloc 1

**MAIS**

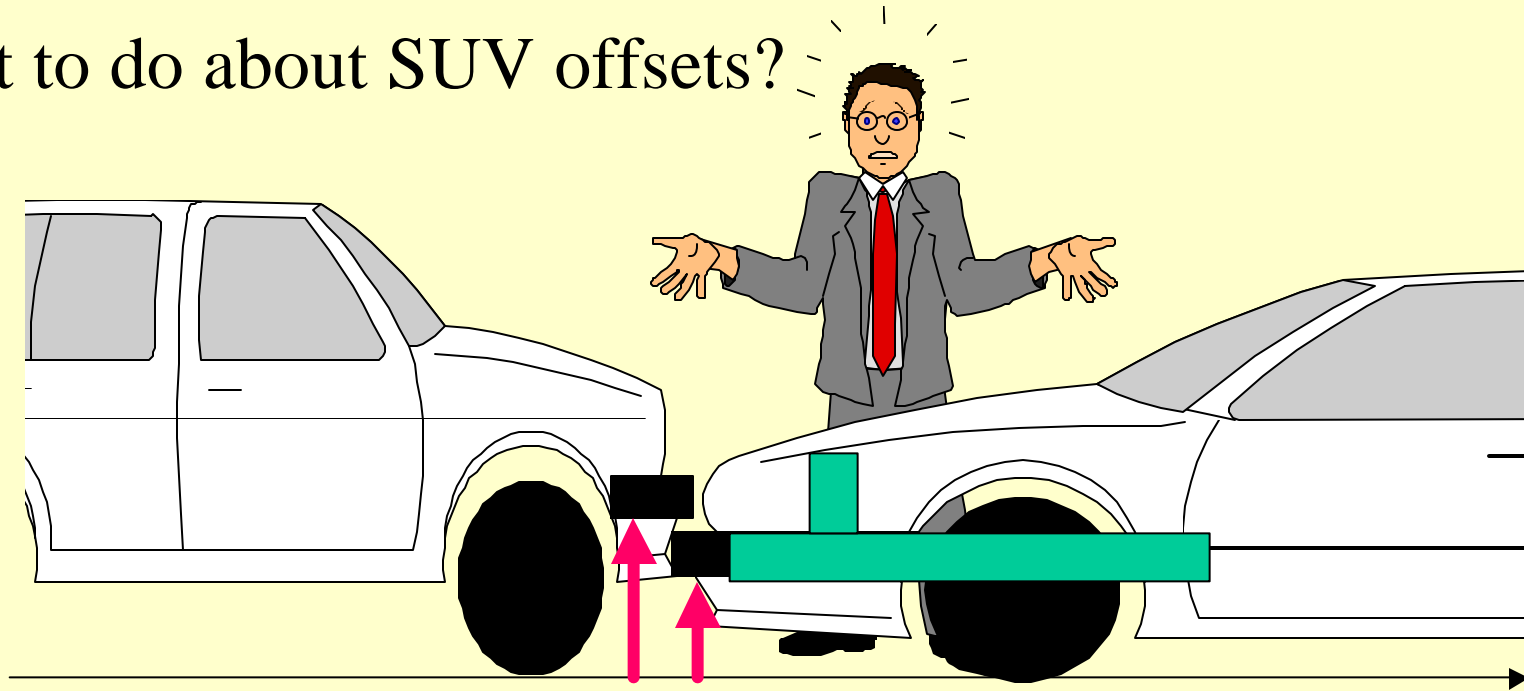
**3**

**ISS**

**11**

# Conclusion

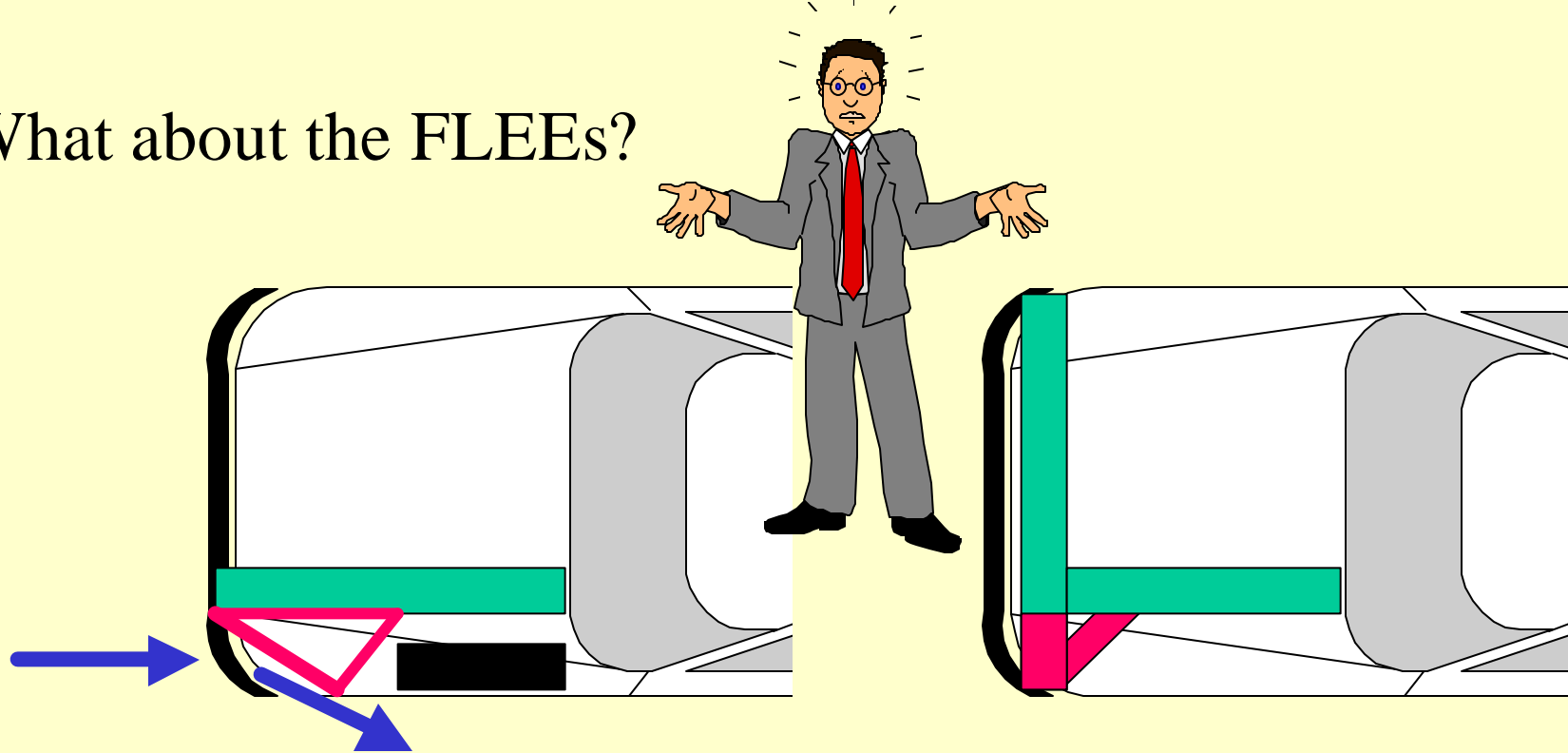
What to do about SUV offsets?



Rather than lower the support on the SUV create a vertical component on the frame rail of the sedan?

# Conclusion

What about the FLEEs?



Need to brace and deflect the impact or  
extend the bumper support to the corner

# Case Reviews Conclusion

A frontal offset impact into an SUV can create significant intrusion of the hood, and instrument panel area of compact sedans/others and increases injury severity to the lower extremities and thorax.

Offset FLEE impacts can be very severe, and could create a lateral component of intrusion along with rotation to the vehicle where both could exhibit an additional occupant contact which increases the injury severity.

The combination of an SUV with an offset FLEE can be severe or even fatal.